DOCUMENT RESUME

ED 166 348 UD 019 162

AUTHOR Murnane, Richard J.; Phillips, Barbara R.
TITLE Effective Teachers of Inner City Children: Who They Are and What They Do.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C. Finance and Productivity Group.
PUB DATE [78]
CONTRACT 400-76-157
NOTE 44p.

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Academic Achievement; *Black Students; Disadvantaged Youth; *Effective Teaching; Elementary Education; Individual Instruction; *Research Methodology; *Teacher Characteristics; Teacher Education; Teaching Experience; Teaching Techniques; *Urban Education; Urban Schools; Vocabulary Development
IDENTIFIERS Educational Production Function Research; Process Product Research

ABSTRACT

Investigated in this paper is the extent to which variables used in two major research approaches explain differences in the effectiveness of teachers in improving the vocabulary skills of inner city black children in four elementary grade levels. The two approaches investigated, educational production function research and process-product research, are described in terms of a multivariate model which takes into account teacher characteristics and other factors which affect children's achievement. Results of the study indicate that concepts used in both approaches provide indicators of teacher effectiveness. In particular, the general teaching approach known as direct instruction is described as being especially effective in teaching children from low income families. In addition, it is pointed out that teaching experience is related to teaching effectiveness. These findings are explained, their relationships discussed, and their implications for teacher training are outlined. A list of references is also included. (Author/EB)

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ED166348

FEB 20 1979

EFFECTIVE TEACHERS OF INNER CITY CHILDREN: WHO THEY ARE AND WHAT THEY DO

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This research was supported by the Finance and Productivity group of the National Institute of Education under Contract No. 400-76-157. It does not, however, necessarily reflect the views of that agency.

We would like to thank Jennifer Proga and Kenneth Goldberg for research assistance; and James Knickman, Larry Manheim, Rebecca Maynard, Carl Milofsky, Edward Pauly, and James Rosenbaum for helpful comments on an earlier draft.

We would also like to thank the officials of the Midcity school district for their cooperation.

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EFFECTIVE TEACHERS OF INNER CITY CHILDREN: WHO THEY ARE AND WHAT THEY DO

I. INTRODUCTION

Since the publication of the Coleman Report in 1966, there has been considerable pessimism about the impact of schooling on children's learning. Only in the last few years has statistical evidence begun to accumulate to indicate that "schooling matters". Perhaps the clearest evidence comes from analyses that show significant differences in the learning of children in different classrooms, even after taking into account the children's skill levels when the school year began.[1/] Attempts to explain why learning differs across classrooms and the role of the teacher in influencing student achievement have not been very successful (Meyer 1978). Despite a vast number of studies, there is little consistent evidence about the nature of effective teaching. In a comprehensive review of the teacher effectiveness literature, Averch et al. (1972) suggested that the lack of success is due in large part to the fragmented nature of educational research. Researchers from many disciplines study teacher effectiveness, approaching the topic from different perspectives and using different models and data sets; little cross-fertilization, synthesis or replication occurs.

In this paper, we address the fragmentation of educational research by investigating the extent to which variables used in two major research approaches--educational production function research and process-product research--explain differences in the effectiveness of teachers in improving the vocabulary skills of inner-city black children in four elementary grade levels. In each case the variables

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[1/] Among these studies are Hanushek (1970), Murnane (1975), Armor et al. (1976).

describing teachers are embedded in a multivariate model that also takes into account other factors affecting children's achievement.

The results of our research indicate that concepts used in both process-product research and production function research provide indicators of teaching effectiveness. In particular, the general teaching approach known as direct instruction is especially effective in teaching the children from low income families that comprise our sample. Also, teaching experience is related to teaching effectiveness in a systematic, but nonlinear fashion. Later in the paper we explain these findings, discuss their relationship, and suggest implications for teacher training. We begin, however, with a description of the two research approaches.

II. TWO APPROACHES

A. EDUCATIONAL PRODUCTION FUNCTION RESEARCH[1/]

An important strength of the educational production function approach is the explicit recognition that the influence of teachers on student achievement can best be assessed in the context of a model that takes into account the influences of other determinants of achievement. The newest studies, which use longitudinal data and

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[1/] The term "educational production function" is unfortunate because the term "production function" has a very specialized meaning to economists which is inappropriate for studying the relationship between teachers and student achievement. For a comprehensive discussion of this point, see Hanushek (1978).

match children to their teachers, estimate a model of the following general form:

$$A_t = a + bA_{t-1} + cD + dF_t + fP_t + gS_t + hT_t + e_t \quad (1)$$

[1/]

where

A_t = achievement at the end of a particular school year, t

A_{t-1} = achievement at the end of the previous school year, t-1

D = a vector of the child's demographic characteristics

F_t = a vector of family characteristics in year, t

P_t = a vector of schoolmate characteristics in year, t

S_t = a vector of school characteristics in year, t (excluding teacher attributes)

T_t = a vector of teacher attributes in year, t

e_t = an error term that is assumed to be normally distributed with zero mean and contant variance

The research described in this paper also employs a model of this form.

The teacher attributes commonly used in production function studies include sex, race, verbal ability, information about the teacher's training (e.g., quality of undergraduate college, number of degrees), and years of teaching experience. There are two reasons for choosing variables of this type. First, they are readily available to school-district officials who make hiring decisions. If these variables did predict effective teaching, they would be helpful

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[1/] To simplify the notation all vectors of coefficients are defined to be column vectors.

in selecting teachers. Second, these variables are easy to collect for large numbers of teachers because the information is available in personnel records.

Unfortunately, a survey of production function results does not reveal a set of teacher characteristics that is consistently related to effective teaching.[1/] Each study finds that some characteristics are important, but there are substantial inconsistencies across studies. The primary reason for these disappointing results may be that the variables typically used in production function studies to describe teachers are far removed from the attributes of teachers that children actually experience. From the child's point of view it may be the behavior that a teacher displays that matters. A primary goal of our research is to test the hypothesis implicit in production function research that variables describing teachers' backgrounds and training serve as useful proxies for teacher classroom behavior.

[1/] Six teacher characteristics are examined in our research: years of teaching experience, Master's Degree, verbal ability, prestige of undergraduate college, race, and sex. They were chosen either because they are determinants of a teacher's salary and thus are of concern to school district officials, or because they have been related to teaching performance in recent studies based on longitudinal information on individual children.

B. PROCESS-PRODUCT RESEARCH

Process-product research examines the effectiveness of particular aspects of teaching behavior, such as grouping practices, use of praise, and questioning techniques. The great strength of this research approach is that it focuses on attributes of teachers that children experience directly. This approach could have important policy implications for teacher training if a set of teaching techniques was found to be consistently effective in increasing children's achievement.

Unfortunately, most process-product research has not been able to find a set of consistent relationships between teacher behavior and student achievement. As Dunkin and Biddle pointed out in a 1974 summary of past research (p. 417), "One of the striking things about product-oriented research on teaching to date is how often investigators have failed to obtain a predicted relationship."

One compelling explanation for the lack of significant, consistent results concerns the statistical methods used in these studies. Most process-product studies examine very small samples using bivariate analysis techniques. The consequence of small sample size is that it is very difficult to reject the null hypothesis that differences in teacher behavior do not result in differences in student learning. Reliance on bivariate correlational techniques makes it impossible to separate teacher effects from the many other factors affecting student achievement and to isolate the effect of a particular teacher behavior.

Despite the disappointing results of most process-product research, several recent studies have produced tentative results concerning the behavior of effective teachers. Particularly relevant to our research is a group of results that suggest a general teaching approach which is effective in teaching elementary school children from low socioeconomic backgrounds. Rosenshine (1976), who calls this approach "direct instruction", describes it as follows (pp. 63-64):

> In direct instruction a great deal of time is spent on academic activities, with a predominance of seatwork using structured materials. Teachers' and workbook questions are narrow and direct, usually with a single correct answer. Teachers or materials provide immediate feedback using praise and acknowledgement of student answers. Students work in groups supervised by the teacher with little free time or unsupervised activity, resulting in less off-task student behavior.
>
> The results of some studies also suggest that in direct instruction, the teacher is the dominant leader who decides which activities will take place. The learning is approached in a direct businesslike manner and is organized around questions posed by the teacher or the materials. Materials and instruction are systematically organized, proceeding with small steps. Goals are clear and known to the student. Yet, within this task setting the teacher is warm and convivial, frequently giving praise and encouragement to the students for academic work.

Three general themes emerging from the direct-instruction hypothesis are the importance of a businesslike orientation on the part of the teacher; the creation of a learning environment that maximizes the amount of time that students spend actually working at learning tasks; and a structured curriculum which emphasizes feedback. The importance of the first two themes is evident in the descriptions that teachers give of the behavior of their most effective colleagues (Lortie 1975). In our investigation of the relationships between particular teaching behavior and teaching effectiveness, we focus particularly on variables that are related to the above themes. These variables are listed in Table 3.

III. THE DATA

The data for this study were collected in conjunction with a federally funded welfare reform experiment in a large midwestern city, which we will call Midcity. All of the families in the experiment (and consequently all of the children in our samples) were black; more than half of the families were headed by females; and most had very low incomes. The teachers studied were predominantly black and female. Many were very experienced and most had Master's Degrees.[1/]

[1/] It should be mentioned that Midcity is in some respects a very special city. It has a long tradition of innovative education, with particular emphasis on improving the skills of poor children. Because of this, we suggest caution in generalizing the results of this study to other localities.

Information on achievement test scores,[1] class assignments, and school characteristics was collected from school records. Information on children's demographic characteristics and home environment was obtained in interviews with parents. Information on teacher background, attitudes, and behavior was collected through a questionnaire administered to all elementary school teachers.[2] The questionnaire drew heavily on questions designed by Brophy and Evertson (1976) on the basis of their review of the process-product literature.

The analysis samples included all children in grades three through six who met the following criteria:[3]

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[1] The tests were the vocabulary component of the Iowa Test of Basic Skills (1965) for the appropriate grade levels.

[2] Approximately two-thirds of the teacher questionnaires were completed and returned.

[3] The set of children satisfying criteria 2 and 3 would not necessarily constitute a random sample of the children whose families participated in the welfare reform experiment. We evaluated the representativeness of our samples by comparing the available information on the number of absences, grade-point averages, and achievement test scores of children in the analysis sample and children who were eliminated because of incomplete data. We found no important differences.

1. Their families participated in the welfare reform experiment.
2. Achievement test scores were available.
3. Their classroom teacher completed the teacher questionnaire.[1/]

IV. ARE THERE DIFFERENCES AMONG CLASSROOMS?

Before we began our analysis of the determinants of teacher effectiveness, we tested the hypothesis that the effect of an additional year of schooling on a child's achievement depends on the classroom in which the child spent the school year. This is a critical question because our information on teachers can explain only that part of the variation in student achievement that consists of differences among classroom averages. To test this hypothesis we used an F test to compare the explanatory power of the following two equations:

[1/] The teacher questionnaire information was collected at the end of the 1974-75 school year. Data on student achievement were available for that school year and for the 1972-73 and 1973-74 school years as well. In order to use the teacher questionnaire data with the earlier achievement data, we assumed that teachers in the sample had the same attitudes and classroom behavior in 1974-75 as in the two previous years. We examined this assumption by testing whether the teacher behavior reported on the 1975 questionnaire explained the achievement of students that teachers taught during the 1975 year better than it explained the achievement of students that the teachers taught in earlier school years. We found no significant differences.

$$A_t = a + bA_{t-1} + dB + e_t \quad (2)$$

$$A_t = bA_{t-1} + dB + \sum_k c_k C_k + e_t \quad (3)$$

where

A_t = achievement at the end of a particular school year, t

A_{t-1} = achievement at the end of the previous school year, t-1

B = vector of variables describing the child and his family

C_k = a dummy variable for the kth classroom

The results, which are displayed in Table 1, indicate that in predicting a child's vocabulary skills at the end of grades three through six, it is important to know in which classroom the child spent the school year. Thus, there is a solid basis for investigating whether variables describing classroom teachers can explain the achievement of students in these grades.

V. ARE VARIABLES DESCRIBING TEACHER CHARACTERISTICS AND TEACHER BEHAVIOR SUCCESSFUL IN EXPLAINING STUDENT ACHIEVEMENT?

In this section we discuss our tests of hypotheses concerning the explanatory power of variables describing teacher characteristics and teacher behavior. The hypotheses that we address can be illustrated in

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[1] The coefficients of A_{t-1} and B in equations 2 and 3 (and in equations 4-7) were not constrained to assume the same values in each equation. We did not use different symbols in each equation because we thought that the large number of symbols would be confusing.

TABLE 1

TESTING THE CONTRIBUTION OF CLASSROOM IDENTIFICATION TO THE EXPLANATION OF STUDENT ACHIEVEMENT

Grade Level of Students	Number of Students	Number of Teachers [a/]	R^2 for Model without Classroom Identification	R^2 for Model with Classroom Identification	F Statistics Testing Contribution of Classroom Identification
Third	171	23	0.43	0.62	3.10**
Fourth	176	20	0.29	0.71	11.19**
Fifth	159	22	0.36	0.56	2.64**
Sixth	168	17	0.24	0.55	6.34**

[a/] A teacher is included only if observations on three or more of his students are available. Likewise, a student is included only if three or more observations were available for his teacher.

**Significant on a one percent test.

terms of the Venn diagram presented in Figure 1. The rectangle N represents the extent to which differences among classrooms explain student achievement. Circle P represents the ability of the teacher characteristics to account for the variation in student achievement. Circle Q represents the ability of the variables describing teacher behavior to account for this same variation. The intersection of the circles, I, represents the portion of the variation in student achievement that is jointly explained by the two sets of variables.

Our analysis tests the following hypotheses:

1. Teacher characteristics explain a significant portion of the variation in student achievement. (Circle P constitutes a significant portion of the rectangle N.)

2. The variables describing teacher behavior explain a significant portion of the variation in student achievement. (Circle Q constitutes a significant portion of rectangle N.)

3. The teacher characteristics provide unique information about the effectiveness of teachers; that is, information not also provided by the description of teacher behavior. (The portion of circle P not included in section I is a significant portion of rectangle N.)

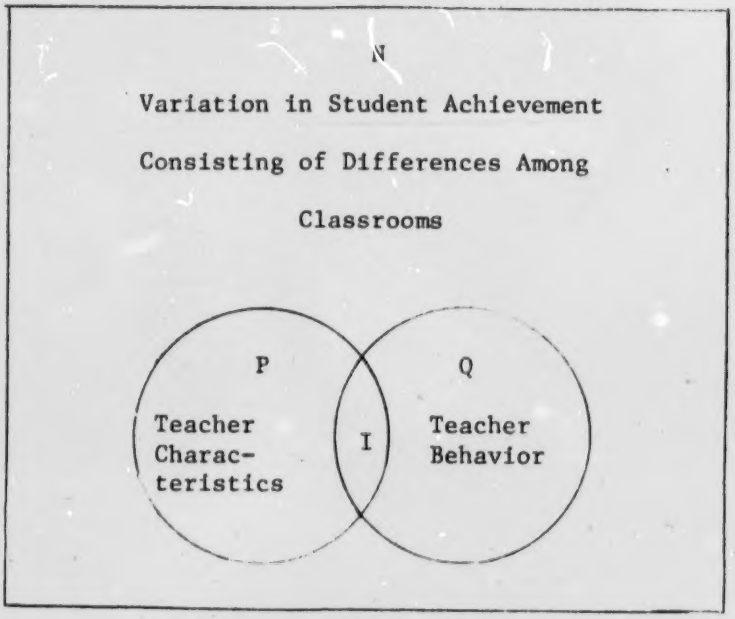
4. The variables describing teacher behavior provide unique information about the effectiveness of teachers; that is, information not also provided by the teacher characteristics. (The portion of circle Q not included in section I is a significant portion of rectangle N.)

To test these hypotheses, we use F tests to compare the explanatory power of the following four models:

FIGURE 1

VENN DIAGRAM ILLUSTRATING TWO WAYS OF

DESCRIBING TEACHERS



Model A: $A_t = a + bA_{t-1} + dB + e_t$ (4)

(the control model)

Model B: $A_t = a + bA_{t-1} + dB + pP + e_t$ (5)

Model C: $A_t = a + bA_{t-1} + dB + qQ + e_t$ (6)

Model D: $A_t = a + bA_{t-1} + dB + pP + qQ + e_t$ (7)

where

P is a vector of variables describing teacher characteristics,

Q is a vector of variables describing teacher classroom behavior.

All other variables retain the definitions from equation 2.

Notice that all of these are multivariate models of the type depicted in equation 1. The specifications of model B and C are identical to the specifications used in later sections of this paper in which we describe the particular teacher attributes that are related to effectiveness.

To test the first hypothesis, we compared the explanatory power of model A and model B for each grade level sample. The results of these tests (and the other tests discussed in this section) are presented in Table 2. The significant F tests indicate that the variables describing teacher background, training, and experience do explain a significant portion of the variation in student vocabulary achievement at every grade level.

We tested the second hypothesis by comparing the explanatory power of models A and C. The significant F tests indicate that the variables describing teacher classroom behavior also explain a significant portion of the variation in students' achievement at every grade level.

TABLE 2

A COMPARISON OF THE RELATIVE EXPLANATORY POWER OF THE BEHAVIOR AND CHARACTERISTICS VARIABLES

	Grade Level[a]			
Independent Variable	3	4	5	6
R^2 Model A (The Control Model)[b]	0.52	0.45	0.38	0.42
R^2 Model B (The Characteristics Mocel)[c]	0.55	0.60	0.45	0.55
R^2 Model C (The Behavior Model)[d]	0.60	0.64	0.48	0.61
R^2 Model D (The Combined Model)	0.62	0.66	0.54	0.63
Percent of variance unique to characteristics variables	2	2	6	2
Percent of variance unique to behavior variables	7	6	9	8
F test for Hypothesis 1	2.02*	8.72**	3.08**	7.51**
F test for Hypothesis 2	2.90**	8.61**	2.99**	7.09**
F test for Hypothesis 3	1.60	1.48	2.63**	1.19
F test for Hypothesis 4	2.60**	2.83**	2.68**	2.90**

FOOTNOTES TO TABLE 2

a/ There are 205 observations in the third grade, 207 in the fourth, 199 in the fifth, and 203 in the sixth.

b/ There are sixteen control variables (including the constant term) in each model.

c/ There are eight characteristics variables in the fourth and fifth grade models and seven in the third and sixth grade models.

d/ There are twelve behavior variables in every model except that for the fourth grade, which contains eleven.

* Significant on a five percent test.

**Significant on a one percent test.

We tested the third hypothesis by comparing the explanatory power of models C and D. The results of the F tests indicate that at only one of the four grade levels (grade five) do the teacher characteristics explain a significant portion of the variation in students' vocabulary achievement that is not explained by the variables describing teacher behavior. In a later section we examine whether the teacher characteristics serve as sytematic indicators of particular teacher behaviors.

We tested the fourth hypothesis by comparing the explanatory power of models B and D. At all four grade levels, the unique contribution of the information on teacher behavior was significant in explaining students' vocabulary achievement. This indicates that information about teacher behavior that is important in explaining the effectiveness of teachers is not captured by the easier-to-collect information on teacher characteristics. Thus, the teacher characteristics do not provide good proxies for teacher behaviors.

Overall, the results of the tests described in this section suggest that variables describing teacher behavior and variables describing teacher characteristics are both important in predicting teaching effectiveness. In the next two sections, we discuss the relationship to student achievement of particular variables describing teacher behaviors and characteristics.

VI. WHICH ASPECTS OF TEACHER BEHAVIOR ARE SYSTEMATICALLY RELATED TO TEACHING EFFECTIVENESS?

In this section we discuss our evidence (presented in Table 3) concerning the teaching behaviors that are systematically related to student learning. Two general themes emerge. First, there is some support for the hypothesis that the direct-instruction strategy is particularly effective for teaching poor children. Second, there are significant differences in the results across grade levels. We discuss these themes in turn.

A. SUPPORT FOR THE DIRECT-INSTRUCTION HYPOTHESIS

The support for the direct-instruction hypothesis comes from the regression results indicating significant relationships between variables pertaining to the direct-instruction teaching strategy and student achievement. The following paragraphs summarize these findings.

1. Repetition of Poor Work

For both the fifth and sixth grade samples, the policy of having students repeat poor work is positively related to achievement. This practice is consistent with one of the themes of direct instruction: teachers who are demanding and have a businesslike attitude about their role are likely to insist that students repeat poor work. This result also suggests the importance of teacher feedback. If work is not corrected, children do not learn from their mistakes and will not go on to master skills.

2. Correction of Seatwork

The importance of feedback is also evident in the results on the

TABLE 3

RESULTS INDICATING THE EFFECT OF TEACHER BEHAVIOR[a/]

(t statistics are in parentheses; * indicates significant on a two-tailed five percent test.)

Independent Variable	Grade Level 3	4	5	6
Direct Instruction Variables				
Students repeat poor work	1.179 (1.070)	0.280 (0.204)	2.595* (2.075)	3.358* (2.108)
Circulates around room to correct seatwork	0.092* (3.874)	0.025 (1.191)	0.004 (0.179)	-0.017 (-0.584)
Student movement around room discouraged	1.330 (0.877)	0.954 (0.728)	-2.614 (-1.456)	7.397* (3.634)
Views job as explaining subject matter	0.060 (0.066)	1.033 (0.968)	5.648* (4.541)	2.444 (1.290)
Percent of time subgroups used	-0.115* (-2.976)	0.036 (1.074)	0.027 (0.604)	-0.164* (-2.684)
Other Behavior Variables				
Instruction "pitched" to middle achievers	0.668 (0.482)	3.747* (3.162)	1.100 (0.715)	0.012 (0.008)
Percent of time uses demonstrations	0.106* (2.745)	-0.068* (-1.977)	0.015 (0.292)	-0.108 (-1.864)
Percent of time to individualized work	-0.090 (-1.815)	-0.050 (-1.019)	0.140* (2.670)	0.003 (0.040)
High amount of public praise	-1.942 (-1.555)	-5.624* (-3.291)	-2.953* (-2.211)	5.222* (2.513)
Dramatic lessons effective	0.759 (0.475)	b/	-1.472 (-0.957)	7.385* (2.989)
Percent of times uses whole word approach	-0.030 (-1.367)	-0.051 (-1.712)	-0.000 (-0.014)	0.006 (0.227)
Severe disruptions occur frequently	-1.330 (-1.389)	0.002 (0.002)	-1.327 (-1.145)	3.195 (1.473)

a/ The complete regression results are available from the authors.

b/ Variable was excluded because too few observations were available.

correction of seatwork. Circulating around the room to correct seatwork is positively related to effectiveness in teaching vocabulary to children in the third grade. Brophy and Evertson (1976) also found that this procedure was effective with children in the second and third grades.

3. Student Movement About the Classroom

For the sixth grade sample, the classroom control technique of discouraging movement about the classroom is positively related to student achievement. This is compatible with two themes in the direct-instruction approach: a businesslike orientation on the part of the teacher and the creation of a disciplined environment that maximizes the amount of time that students spend on learning tasks.

4. The Teacher's Perception of Role

Our results for the fifth grade sample indicate that teachers who view their jobs primarily as being responsible for teaching and explaining subject matter are particularly effective. The importance of viewing one's role as a teacher primarily in terms of subject matter supports the direct-instruction view of the effective teacher as businesslike and task-oriented.

5. Group Instruction

A high proportion of class time spent in group activities (as opposed to individualized or whole-class instruction) is associated with low vocabulary achievement for children in the third and sixth grades. A possible explanation for the ineffectiveness of extensive group work concerns teacher supervision. Group work is difficult to

supervise. When children are discussing material without close teacher supervision, their attention wanders easily.

Other Variables Describing Teacher Behavior

Instructional Level. When teaching in a heterogeneous class, teachers often direct instruction to a single achievement level. They design lessons with a certain level in mind and provide supplemental instruction as necessary to children at other levels. Directing instruction to middle achievers is positively related to the vocabulary achievement of children in the fourth grade. One explanation for this result is that low achievers may become disruptive or withdrawm if they cannot comprehend the lesson. Higher achievers may also become disruptive if they become bored when the lesson is too easy. Perhaps the best way to minimize disruptive behavior in a heterogeneous classroom is to direct instruction to middle achievers.

We also included in our model several other variables describing teaching techniques. However, the coefficients on these variables were either insignificant for all grade levels, had conflicting signs at different grade levels, or were very sensitive to the specification of the model.

Summary and Policy Implications

Our results provide some support for the direct-instruction hypothesis. This support must be considered tentative because the values and significance of the individual coefficients vary across

grade levels. Nonetheless, this support is important because our research is based on a multivariate model which controls for other factors which affect achievement. Most of the previous support for the direct-instruction hypothesis came from studies which did not take into account other factors affecting achievement.

It is important to note that the direct-instruction approach contrasts sharply with the progressive education tradition that has dominated educational psychology since the turn of this century, and which, in a moderated form, continues to dominate most teacher training programs today (Dunkin and Biddle, 1974). The basic tenet of the progressive education tradition is that teaching is best understood by studying the climate of the classroom. The assertion is that a "bad" teacher is autocratic and teacher-centered, and that a "good" teacher is democratic and student-centered. Yet, direct instruction is a teacher-centered process. Given the goal of increasing achievement,[1/] our evidence suggests that training in the progressive tradition should not be emphasized for prospective teachers of poor children.

B. WHY DO THE RESULTS VARY ACROSS GRADE LEVELS?

In evaluating our results, we must face the issue of why the results vary across grade levels. On the basis of the F test results reported in section V, we reject the explanation that the significant

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[1/] It is only fair to note that the progressive tradition does not focus on cognitive achievement.

coefficients are the result of chance. These F tests indicate that the cluster of variables describing teacher behaviors which are included in our model explain a significant portion of the variation in students' vocabulary achievement at all four grade levels. Consequently, other explanations must exist. In the following paragraphs we consider a number of possible, complementary alternatives.

1. Different Teaching Techniques are Effective at Different Grade Levels

Some of the differences in results may be the result of real differences in the effectiveness of teaching techniques at different grade levels. For example, the technique of circulating around the room to correct seatwork may be particularly effective with young children, but not with children in the later elementary grades.[1/]

2. Small Samples

Our grade level samples, although quite large relative to the samples used in most other research on teacher behavior, may be too small to provide stable estimates of the impact of individual teaching

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[1/] There is some evidence that supports this position. In contrast to our results and those of Brophy and Evertson (1976) for second and third grade children, Good and Grouws (1977) found that fourth grade mathematics teachers who went to their students' desks to answer questions were ineffective.

techniques on student learning.[1/] Sample size may be an especially important consideration in models of teacher behavior because collinearity among the variables describing different aspects of teacher behavior makes the task of isolating teacher effects particularly difficult.[2/]

It is important to remember that we are aware of the multicollinearity problem only because we use a multivariate model in our research. The fact that teaching is an extremely complicated process that cannot be summarized by one or even a few variables affects all

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[1/] We investigated the effect of sample size by pooling our data on adjacent grade levels (third and fourth, fifth and sixth) and reestimating our models on the pooled samples. We hoped that these larger samples would yield more stable results. However, the results of F tests led to the rejection of the hypothesis that the structure of the model was the same across consecutive grade levels. As a result, pooling was not justified.

[2/] Our approach to the intricate pattern of collinearity in our data was extensive testing of the sensitivity of the results to the specification of the model. Variables that were sensitive to the specifications in all grade levels were deleted. An attempt to form indices from the collinear variables was unsuccessful; we were unable to find indices that were consistent across grade levels. For more information on our approach to collinearity, see Murnane and Phillips, 1978.

research on the determinants of teacher effectiveness. This may explain the large number of inconsistencies in the results of process-product research that traditionally employs bivariate analysis techniques. Only with a multivariate framework can one attempt to separate the effects of particular teaching techniques from the effects of related techniques.

3. Interaction Effects

It may be that effective teaching of inner city children cannot be defined in terms of the use of a particular set of techniques. The general approach of direct instruction may be effective, but successful implementation of this strategy may require that the teacher find the techniques that best fit his or her personality, the curriculum, the available materials, and the backgrounds of the students in the class.[1/] In other words, interaction effects could be critical. The reason that our results differ across grade levels may be that there are subtle differences across grades in teachers, students, curriculum and materials that we did not take into account--although we did investigate a variety of interaction effects.[2/] In the next section we explore

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[1/] See Berman and McLaughlin (1978) for a discussion of the importance of implementation.

[2/] Among the characteristics of children that we did investigate for interaction with teaching techniques is prior achievement. Brophy and Good (1974) argue that this is a particularly important source of interaction effects. We found no significant interaction effects, however. An example of a more subtle interaction effect that we could

whether there are identifiable characteristics of teachers that provide information about how successful they are in finding teaching techniques that result in high student achievement.

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not investigate is Cronbach and Snow's suggestion (1977) that a child's response to a particular teaching style depends on the styles of his previous teachers.

Another possible explanation for the differences in results across grade levels is that the use of self-administered questionnaires to collect data about teaching techniques and priorities introduces significant measurement error into the information about teacher behavior. This could occur for a number of reasons. First, the questionnaire items may not address succinctly the critical questions concerning differences in teaching strategies. Second, teachers may not be aware of what they are doing as they cope more or less successfully with the many demands placed on them each day. Third, teachers may not respond honestly to questions that have a socially or professionally desirable response. Whether the problems associated with self-report data are more severe than the problems posed by alternative methods of data collection, such as observation, is difficult to evaluate. The fact that the questionnaire items dealing with teacher behavior explain a significant portion of the variation in student achievement is cause for optimism. However, the questions must be refined, and the validity of teachers' responses to the self administered questionnaire must be investigated by comparing them with the results of direct observation.

VII. WHICH TEACHER CHARACTERISTICS ARE SYSTEMATICALLY RELATED TO TEACHING EFFECTIVENESS?

In this section we discuss our evidence (presented in Table 4) concerning the teacher characteristics that are significantly related to teaching effectiveness. We would like to remind the reader that, as we discussed in Section V, the teacher characteristics as a group explain a significant portion of the variation in the vocabulary achievement of students in all four grade levels. Consequently, there is good reason to believe that the teacher characteristics provide important information concerning which teachers are particularly effective. As we discuss below, however, virtually all of the explanatory power comes from the information on teacher experience.

A. TEACHING EXPERIENCE

The relationship between teaching experience and effectiveness in a cross-section of teachers reflects the influences of three factors: learning-by-doing, vintage effects, and self-selection effects. The learning-by-doing hypothesis states that teachers become more effective over time as they gain experience in accomplishing the complex tasks involved in helping children learn. The vintage hypothesis states that the average abilities of teachers who entered the profession at various times differ. Finally, the self-selection hypothesis states that the effectiveness of teachers who chose to remain in the profession may differ systematically from the effectiveness of those who chose to

TABLE 4

RESULTS INDICATING THE EFFECT OF TEACHER CHARACTERISTICS ON VOCABULARY ACHIEVEMENT[a/]

(t statistics are in parentheses; * indicates significant or a two-tailed five percent test.)

Independent Variable	Grade Level 3	4	5	6
Experience, 7 years or less	0.466 (0.678)	1.555* (2.171)	-0.354 (-0.662)	3.562* (2.513)
Experience, 8 to 14 years[c/]	-0.584* (-2.349)	-0.422 (-1.653)	0.066 (0.264)	-0.811 (-1.666)
Experience, 15 years or more[c/]	0.275* (2.982)	0.407* (4.923)	0.116 (0.595)	0.589* (3.831)
Holds master's degree	0.700 (0.830)	1.645 (1.290)	1.024 (0.883)	-1.589 (-0.902)
Verbal ability score	0.053 (1.341)	-0.035 (-0.576)	-0.030 (-0.472)	-0.353* (-4.953)
Attended prestigious college	0.488 (0.529)	0.706 (0.592)	1.758 (1.663)	2.347 (1.315)
Teacher is white	0.443 (0.285)	-3.114 (-1.605)	-3.699 (-1.819)	b/
Teacher is male	b/	-0.518 (-0.300)	5.201* (3.405)	-5.190* (-2.485)

a/ The complete regression results are available from the authors.

b/ Variable was excluded because too few observations were available.

c/ These coefficients can be interpreted as estimated slopes of the linear relationship between teaching experience and teaching effectiveness within the indicated range of experience. The methods for specifying a linear spline relationship and for calculating the relevant coefficients and t statistics from the regression output are described in Suits et al. (1978).

leave. Because our data are cross-sectional,[1/] we cannot distinguish among the effects of these three factors, but the pattern of our results is suggestive.

Since we expected learning-by-doing to be particularly important in the initial years of teaching, we chose a functional form which allows the relationship between experience and performance to be different for teachers with different levels of experience. After evaluating several alternative specifications, we selected a three piece linear spline specification.[2/] The estimated relationships between experience and teaching performance for the grade level samples are illustrated in Figure 2.

The most striking aspect of the linear spline results is the positive relationship between teaching experience and teaching effectiveness for teachers with more than fourteen years of experience. This relationship is significant for three of the four grade level samples. We suspect that this relationship primarily reflects differences in the innate abilities of teachers who entered the profession at different points in time. Twenty-five years ago, the impact of the post-World War II baby boom had still not hit the nation's schools, and school districts could be quite selective in choosing among candidates for teaching positions. Fourteen years ago, the shortage of

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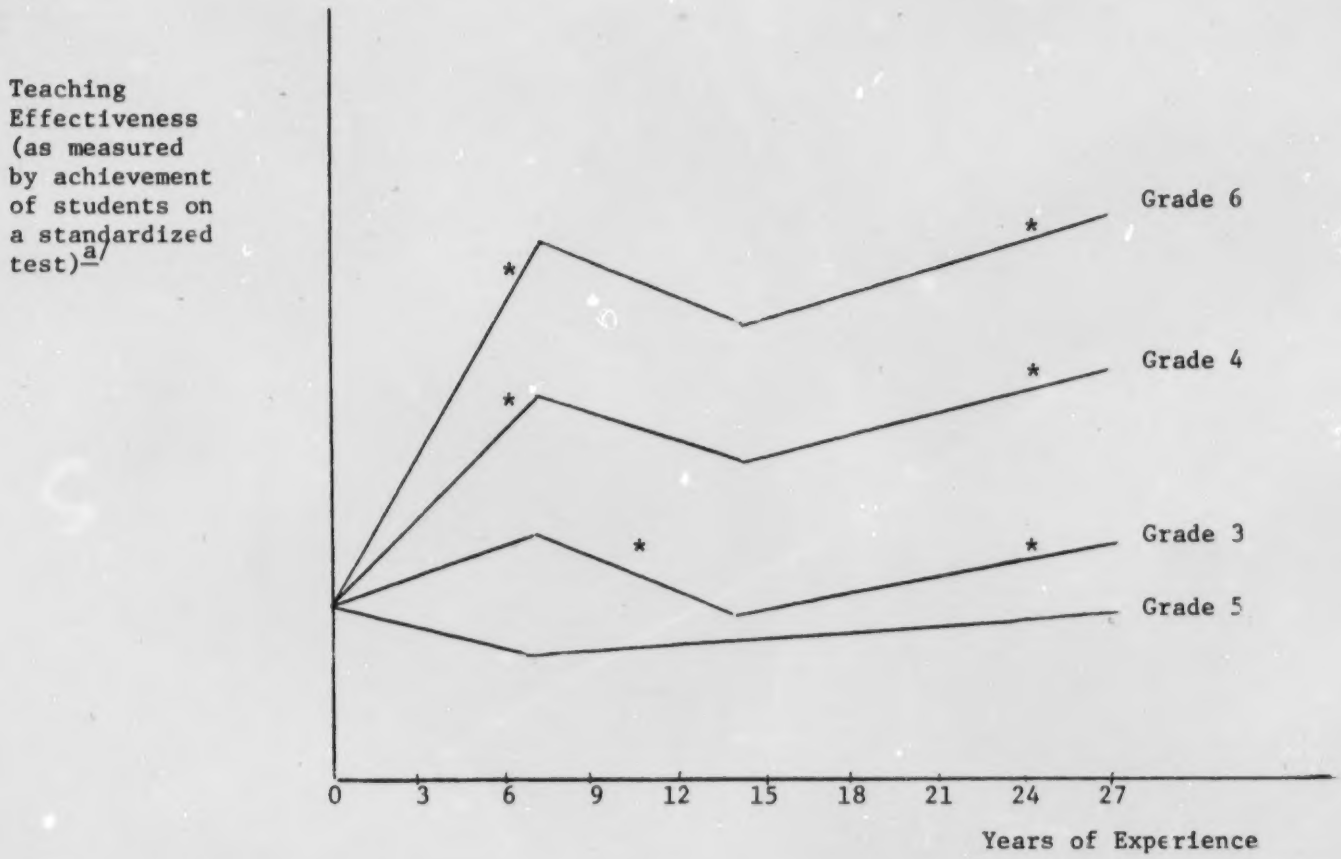
[1/] Our data contain information from three consecutive school years (1973-75). However, because the number of observations for a given year is small, we have pooled across years.

[2/] For a description of spline techniques, see Suits et al. (1978).

FIGURE 2

TEACHING EFFECTIVENESS AS A FUNCTION OF YEARS OF EXPERIENCE



* indicates slope was significantly different from zero on a five percent two-tailed test.

a/ In constructing this graph, the coefficients in Table 4 indicating the relationship between experience and effectiveness were standardized to take into account the fact that the variance in the student test scores used as a measure of effectiveness differed across grade levels.

teachers was acute, particularly in urban areas, and urban school districts could not be selective in hiring teachers.[1/]

A complementary explanation for the very high performance of teachers with more than twenty-five years of experience is that these teachers, who entered the profession when salaries were extremely low, may be particularly dedicated to their work. Also, the teaching profession may have attracted the best black college graduates at that time since they would have had few alternative opportunities for professional employment.[2/]

Our results also indicate a weak negative relationship between experience and performance in the range from seven to fourteen years of experience. (This is significant only for the grade three sample.) We believe that this also reflects the influences of labor market conditions.[3/] Teachers in our sample with fourteen years of experience began their careers in the early 1960's when the teacher shortage was most acute. By the 1966-68 period, when the teachers in our sample with seven years of experience were hired, the teacher shortage had begun to

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[1/] Teachers who leave the profession temporarily and reenter later are also subject to screening at rehiring. In future work, we hope to be able to separate this effect from the screening effect at initial entry.

[2/] In our samples, 81 percent of the teachers with more than fourteen years of experience were black.

[3/] It is interesting to note that neither self-selection nor learning-by-doing can explain the nonmonotonic nature of the relationship between experience and performance for teachers with more than seven years of experience.

ease. (Student enrollments in Midcity peak in 1968.) As a result, administrators could be somewhat more selective in choosing among applicants for teaching positions than they had in preceding years.

For two of the grade level samples (grades 4 and 6), there is a significant positive relationship between experience and performance for teachers with one to seven years of experience. We believe that this reflects primarily the influence of learning-by-doing. In fact our results may underestimate the true positive impact of learning-by-doing, because the teachers in our sample with very little experience may be more talented on average than the teachers with seven years of experience. This stems from the fact that the degree of selectivity that the Midcity school system could exercise in hiring new teachers increased between 1968 and 1975.

B. OTHER RESULTS

Teachers' verbal ability, as measured on a self-administered test, is unrelated to student achievement in three grades. For the sixth grade sample, it is negatively related to student achievement. We believe that this result is spurious, however, because a large number of teachers used aids in completing the test. As a result, the scores are unreliable as measures of ability.

Male teachers were more effective than female teachers in teaching the fifth grade sample, but less effective in teaching the sixth grade sample. We believe that these inconsistent results stem from the small number of male teachers in each grade level sample.

Other teacher characteristics, race, prestige of undergraduate college, and having earned a Master's Degree, are not significantly related to student achievement in any grade level sample.

C. SUMMARY

Years of teaching experience is the one teacher characteristic that is consistently related to teaching effectiveness. We found a positive relationship between effectiveness and experience among highly experienced teachers. The pattern of our results suggests that this relationship reflects differences in the abilities of teachers who entered the profession at different times. We also found a positive relationship between effectiveness and experience for teachers at the beginning of their careers. This result, also reported by Murnane (1975), reflects the impact of learning-by-doing.

VIII. DO TEACHER CHARACTERISTICS PREDICT TEACHING TECHNIQUES?

A. THE EVIDENCE

We reported in Section V that in three of the four grade level samples, most of the variation in student achievement that is explained by teacher characteristics is also explained by the group of variables describing teaching techniques. This indicates that the influence of teacher characteristics on teaching effectiveness operates through the mechanism of teacher behaviors. This leads us to ask the question: Are there consistent relationships between individual teacher characteristics and individual teacher behaviors? In particular, do

teachers with particular levels of experience consistently use particular techniques. To examine this question, we used regression analysis to explore two sets of relationships. First, we regressed teacher experience, the only teacher characteristic consistently associated with student achievement, on the complete set of teacher behaviors in the model. Then we regressed the significant behavior variables on the complete set of teacher characteristics.[1/]

The results of our two sets of regressions indicated almost no consistent relationships across grade levels between teacher characteristics and teacher behaviors.[2/] This is not surprising since we found considerable variation in the teacher behaviors that were related to effective teaching in different grade levels.

B. AN INTERPRETATION

At this point it is useful to summarize our results concerning the impact on teaching effectiveness of teacher behaviors and characteristics and suggest a comprehensive interpretation. The principal results are as follows:

[1/] Since we found that a linear spline specification for experience was appropriate in explaining teacher effectiveness, we used this same specification in predicting aspects of teacher behavior.

[2/] The one consistently significant relationship between teacher characteristics and teacher behaviors that we did observe was that experienced teachers of third to fifth grade classes tended to circulate around the classroom to correct seat work.

1. The general strategy of direct instruction is effective in teaching children from poor families.

2. There is considerable variation across grade levels in the specific teaching techniques that are related to effectiveness.

3. Teaching experience and (by our interpretation) general ability are related to teaching effectiveness.

4. Teachers with particular levels of experience do not consistently use particular teaching techniques.

We suggest the following interpretation of these results. The direct-instruction approach is particularly effective, but successful implementation of this approach requires that the teacher find the techniques that provide the best match of his or her skills and personality with the curriculum, the available materials, and most importantly, with the needs of the children in the class. Experienced teachers and more able teachers are particularly effective because they are most successful in finding techniques that provide a good match. In other words, these teachers find the subtle interaction effects that researchers agree are so important in explaining teaching effectiveness, but yet are so hard to find.

C. IMPLICATIONS FOR TEACHER TRAINING

Our interpretation of the empirical results suggests a two part message for teachers. First, the general strategy of direct instruction seems to be particularly effective in teaching poor children. Consequently, the three themes implicit in this strategy--the importance of a businesslike orientation on the part of the teacher, the creation

of a learning environment that maximizes the amount of time that students spend actually working at learning tasks, and the use of a structured curriculum which emphasizes feedback--should play an important role in the organization of classroom instruction. Second, no particular techniques will work with all children. Moreover, substantial experimentation may be required to find the mix of techniques that best fits the needs of the children in the class and the strengths of the teacher's personality.

Clearly, this is a modest message. It tells teachers what type of general teaching approach may be particularly effective, but it does not tell them exactly what to do to implement this approach. The modesty of this message may make it particularly useful to teachers, however, because it does not promise what every teacher knows does not exist--a recipe for success.

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